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LIST OF ABBREVIATIONS

AFI	—	amniotic fluid index
AFP	—	alpha-fetoprotein
BV	—	bacterial vaginosis
CRL	—	crown rump length
CTG	—	cardiotocogram
EDD	—	expected date of delivery
EFW	—	estimated fetal weight
FGR	—	fetal growth restriction
FHR	—	fetal heart rate
GFR	—	glomerular filtration rate
hCG	—	human chorionic gonadotropin
HPL	—	human placental lactogen
LMP	—	last normal menstrual period
LOA	—	left occipitoanterior
LOP	—	left occipitoposterior
MRI	—	Magnetic Resonance Imaging
ms	—	milliseconds
NICU	—	neonatal intensive care unit;
PAPP-A	—	pregnancy-associated plasma Protein-A
PI	—	pulsatility index
PIGF	—	placental growth factor
ROA	—	right occipitoanterior
SFH	—	symphysis fundal height
sFlt-1	—	soluble fms-like tyrosine kinase
STV	—	short-term variation
WCC	—	white cell count
CRL	—	crown-rump length

Lecture 1

PHYSIOLOGY OF PREGNANCY. METHODS OF EXAMINATION OF PREGNANT WOMEN. PERINATAL CARE

Topic Relevance

During pregnancy, progressive anatomical, physiological and biochemical changes occur in all body systems. It is a phenomenon of maternal adaptation to the needs of the growing fetus. Without proper understanding, these physiologic adaptations of normal pregnancy may be misinterpreted as pathologic.

Systematic examination and counselling of the woman during pregnancy is called prenatal care. Examination should be regular and periodic, according to the needs of the individual. Essentially, prenatal care begins before pregnancy and ends during labor and the postpartum period. Prenatal care consists of careful history taking, examinations (general and obstetric) and counselling.

Educational Materials

PHYSIOLOGICAL CHANGES DURING PREGNANCY. GENITAL TRACT CHANGES

Uterus

The effect of the hormonal stimulation is the greatest on the tissues of the genital tract, and uterine muscle fibers during pregnancy increase 15 times of their length before pregnancy, the uterine weight increases from 50 g to 1000 g correspondingly. At early terms of pregnancy, the growth occurs by hyperplasia, and more particularly by hypertrophy of the muscle fibers, as a result the uterus becomes a thick-walled spherical organ. From the 20th week growth almost ceases and the uterus expands by distension, the stretching of the muscle fibers takes place due to the mechanical effect

of the growing fetus. With distension the wall of the uterus becomes thinner and the shape cylindrical. The uterine blood vessels also undergo hypertrophy and become increasingly tortuous in the first half of pregnancy, but after this no further growth occurs, and the additional length necessary to accommodate the continued stretching of the uterus is achieved by unfolding of the vessels.

The uterus is derived from the two Müllerian ducts and the myometrium is made up of a thin external, largely longitudinal, layer; a thin inner, largely circular layer; and a thick, intricately interlaced middle layer, which comprises two spiral systems of interdigitating muscles derived from the two Müllerian ducts through which the blood vessels run. Apposition of two double curve muscle fibers gives a "8" shape figure. So, when the muscles contract, they occlude the blood vessels running through the fibers and hence called living ligature. The proportion of muscle to connective tissue is the greatest in the fundal area and diminishes as the lower segment of the uterus and cervix is approached, the lower half of the cervix having no more than 10% of muscle tissue.

The effect of the uterine distension is to stretch both interdigitating spiral systems and to increase the angle of crossing of the fibers, in the thinner lower segment area where the fibers cross at an angle of about 160° and are less stretched. Incision of the myometrium in this zone is anatomically more suitable, and experience of the lower segment cesarean section confirms that healing is better.

Contractions (Braxton-Hicks). Uterine contractions during pregnancy were named after Braxton Hicks, who first described their occurrence during pregnancy. From the first weeks of pregnancy, the uterus undergoes spontaneous contractions. This can be felt during bimanual palpation in early pregnancy or by feeling the abdomen, where the uterus becomes hard at one moment and soft at another. The contractions are irregular, infrequent, spasmodic and painless, and do not affect cervical dilation. The patient does not feel the contractions. Later on, the contractions become more frequent and intense, which causes the patient some discomfort.

The lower uterine segment is that part of the lower uterus and upper cervix lying between the line of attachment of the peritoneum

of the uterovesical pouch superiorly and the histological internal os inferiorly. It is that part of the uterus where the proportion of muscle diminishes, this muscle being replaced increasingly by connective tissue (75%), which forms 90% of the cervical tissues (mainly collagen fibers). Because of this the lower uterine segment becomes stretched in late pregnancy as the thickly muscled fundus draws it up from the relatively fixed cervix.

Cervix

The cervix becomes softer and swollen in pregnancy, with the result that the columnar epithelium lining the cervical canal becomes exposed to the vaginal secretions. This change in the cervix is due to estradiol, which increases the hygroscopic properties of the cervical connective tissue and loosens the acid mucopolysaccharides (glycosaminoglycans) of the collagen-binding ground substance.

Prostaglandins effect on the collagen fibers, especially in the last weeks of pregnancy. At the same time, collagenase is secreted from leukocytes, which also aids in the breakdown of collagen. The cervix becomes softer and more easily dilatable — the so-called ripening of the cervix. In this way the cervix is more easily able to dilate in labor.

Vagina

The vaginal mucosa becomes thicker, the vaginal muscle hypertrophies, and there is an alteration in the composition of the surrounding connective tissue, with the result that the vagina dilates more easily to accommodate the fetus during parturition. Estrogen-initiated changes occur early in pregnancy, and there is increased desquamation of superficial vaginal mucosal cells with increased vaginal discharge during pregnancy. If pathogens — bacterial, fungal (e.g. candida) or parasitic (e.g. trichomonads) — enter the vagina, it is easier for them to gain a foothold and therefore vaginitis is more common in pregnancy.

Cardiovascular System

The plasma volume increases to fill the additional intravascular space created by the placenta and the blood vessels. The red cell

mass increases to meet the increased demand for oxygen. Because the increase in red blood cell mass is proportionately less than the increase in plasma volume, the concentration of red blood cells in the blood falls as the hemoglobin concentration falls. Although the hemoglobin concentration falls to about 120 g/L at the 32nd week, total hemoglobin is higher than in the absence of pregnancy. At the same time, the number of white blood cells increases (to about 10,500/mL), as well as the number of platelets (Fig. 1.1).

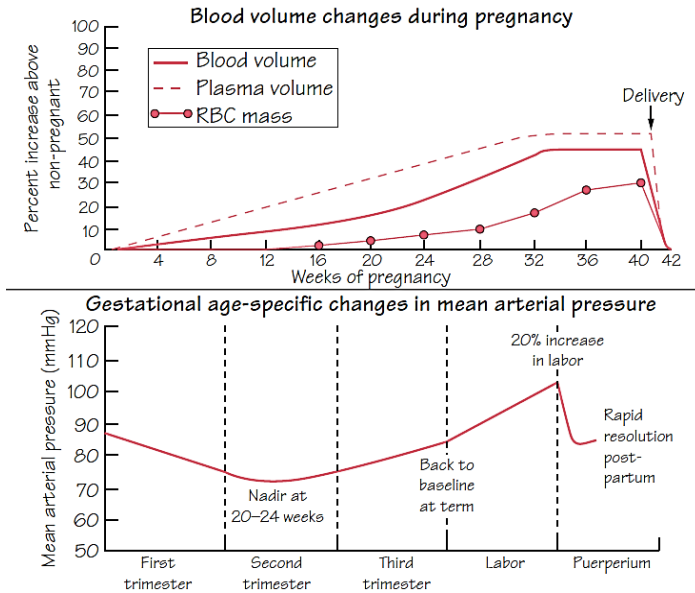


Fig. 1.1.

Source: *Obstetrics and Gynecology at a Glance, 4th Edition* Errol R. Norwitz, John O. Schorge

Cardiovascular dynamics. To cope with the increased blood volume and extra oxygen demand of pregnancy, cardiac output increases by 30–50%. Most of the increased cardiac output is due to an increase in stroke volume, but the heart rate increases by about 15%. The increase in cardiac output is counterbalanced by a decrease in peripheral resistance. For these reasons, blood

pressure decreases in early pregnancy, returning to pre-pregnancy levels by the third trimester.

Like other blood vessels, veins in the legs become dilated. Leg veins are affected especially in late pregnancy due to obstruction of venous return caused by increased pressure of venous blood returning from the uterus and mechanical pressure of the uterus on the vena cava. This may lead to varicose leg veins (and sometimes the vulvar veins) in susceptible women.

Regional distribution of the blood. The uterus receives most of the blood flow required for normal placental perfusion, which reaches 500 ml/min by the end of pregnancy. Renal blood flow and plasma flow increase to 400 mL/min compared to non-pregnant values by week 16 of gestation, and remain at this high level to the end of pregnancy. Blood flow through the capillaries of the skin and mucous membranes increases, reaching a maximum of 300–400 mL/min by week 36. The increased skin blood flow is associated with peripheral vasodilatation. This is the reason why pregnant women “feel the heat”, sweat easily and often profusely, and may complain of nasal congestion.

Respiratory System

Respiratory adaptations during pregnancy aim to optimize maternal and fetal oxygenation and to facilitate the transfer of waste CO₂ from fetus to mother.

Many pregnant women report a subjective perception of shortness of breath (dyspnea) in the absence of pathology. Its reason is unclear (Fig. 1.2, p. 10).

The mechanics of respiration change with pregnancy. The ribs bulge outward and the level of the diaphragm rises by 4 cm.

During pregnancy, tidal volume increases by 200 mL (40%), resulting in a 100–200 mL (5%) increase in vital capacity and a 200 mL (20%) decrease in the residual volume, thereby leaving less air in the lungs at the end of expiration. The respiratory rate does not change. This effect is thought to be due to increased secretion of progesterone. The end result is an increase in minute ventilation and a decrease in arterial PCO₂. Arterial PO₂ slightly raises.

A compensatory decrease in bicarbonate enables the pH to remain unchanged. Thus, pregnancy represents a state of compensated respiratory alkalosis (Fig. 1.3, p. 11).

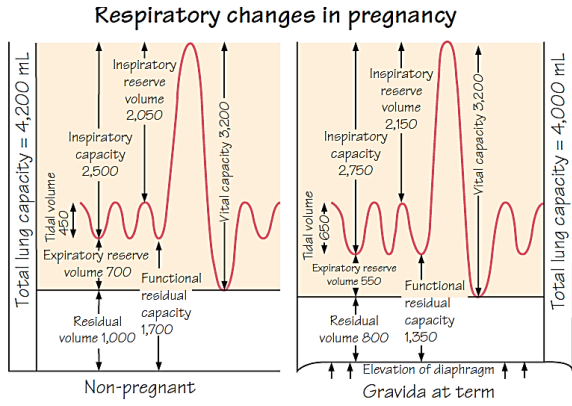
Alimentary System

Nausea (“morning sickness”) occurs in >70% of pregnancies. Symptoms usually go away by 17 weeks.

Progesterone causes relaxation of gastrointestinal smooth muscle, resulting in delayed gastric emptying and increased reflux.

Pregnancy predisposes to cholelithiasis (gallstones). Most gallstones in pregnancy are cholesterol stones.

Pregnancy is a “diabetogenic state” with evidence of insulin resistance and reduced peripheral uptake of glucose (due to increased levels of placental anti-insulin hormones, primarily human chorionic



Effect of pregnancy on pulmonary-function testing

- Forced expiratory volume in one second (FEV₁)...no change in pregnancy (80–85% of vital capacity)
- Forced vital capacity (FVC).....no change (~ 3.5 L)
- FEV₁/FVC ratio.....no change (>85%)
- Peak expiratory flow rate.....no change (~ 450 L/min)

Fig. 1.2.

Source: *Obstetrics and Gynecology at a Glance, 4th Edition* Errol R. Norwitz, John O. Schorge

somatolactotropin or placental lactogen). These mechanisms are designed to provide a continuous supply of glucose to the fetus.

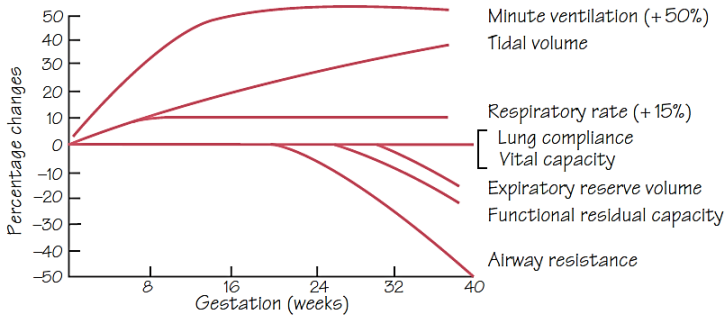
Renal System

Glomerular filtration rate (GFR) increases by 50% early in pregnancy, leading to an increase in creatinine clearance and a 25% decrease in serum creatinine and urea level.

Increased GFR results in an increase in filtered sodium. Aldosterone levels increase two-threefold to reabsorb this sodium.

Increased GFR also results in decreased glucose resorption. Therefore, 15% of normal pregnant women have glycosuria.

Gestational age-specific changes in respiratory function



Oxyhemoglobin dissociation curve in pregnancy

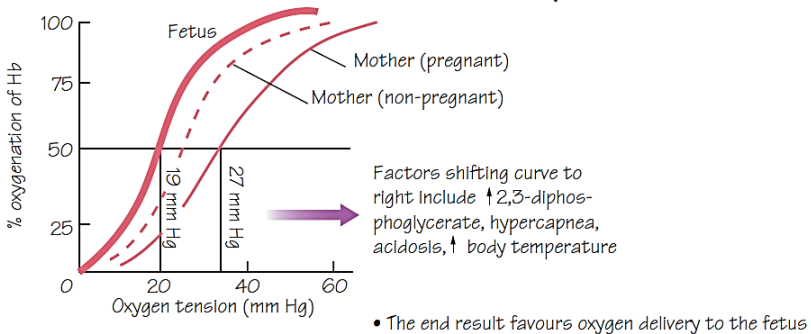


Fig. 1.3.

Source: *Obstetrics and Gynecology at a Glance, 4th Edition* Errol R. Norwitz, John O. Schorge

Moderate hydronephrosis and hydroureter are common sonographic findings that are due to high progesterone levels and partial obstruction from the fetal uterus.

Five percent of pregnant women have bacteria in their urine. Pregnancy does not increase the incidence of asymptomatic bacteriuria, but these women are more likely to develop pyelonephritis (20–30%).

Hematologic System

Increased intravascular volume results in dilutional anemia. Elevated erythropoietin levels lead to a compensatory increase in total red cell mass, but never fully correct the anemia.

A modest increase in white blood cell count (leukocytosis) can be seen during pregnancy, but the differential count should not change.

Mild thrombocytopenia (<150,000 platelets/mL) is seen in 10% of pregnant women. It's rarely clinically significant.

Pregnancy represents a hypercoagulable state with increased circulating levels of factors II (fibrinogen), VII, IX, and X. These changes protect the mother from excessive blood loss at delivery, but also predispose to thromboembolism.

Immune System

Human chorionic gonadotropin can reduce the immune response of pregnant women. In addition, serum levels of IgG, IgA and IgM decrease from the 10th week of pregnancy, reaching their lowest level by the 30th week and remaining at this level.

Weight Gain in Pregnancy

The better absorption of nutrients from the gut, the reduction of muscle tone and thyroid activity produce a decrease in the maternal metabolism. The body adapts to preserve and nourish the growing fetus. During pregnancy a woman inevitably gains weight. A healthy person may expect to gain 12.5 kg (range 9–15 kg) in pregnancy, of which 9 kg is gained during the last 20 weeks. The “ideal” weight gain is only a guide, and has individual variations. However, a woman whose prepregnancy weight is in the normal range (body mass index (BMI) 19–24.9) or who